A publication of the
National Aeronautics and
Space Administration

Mission Highlights STS-81

IS-1997-01-001.081JSC
January 1997

Fifth docking mission continues U.S. work on Mir

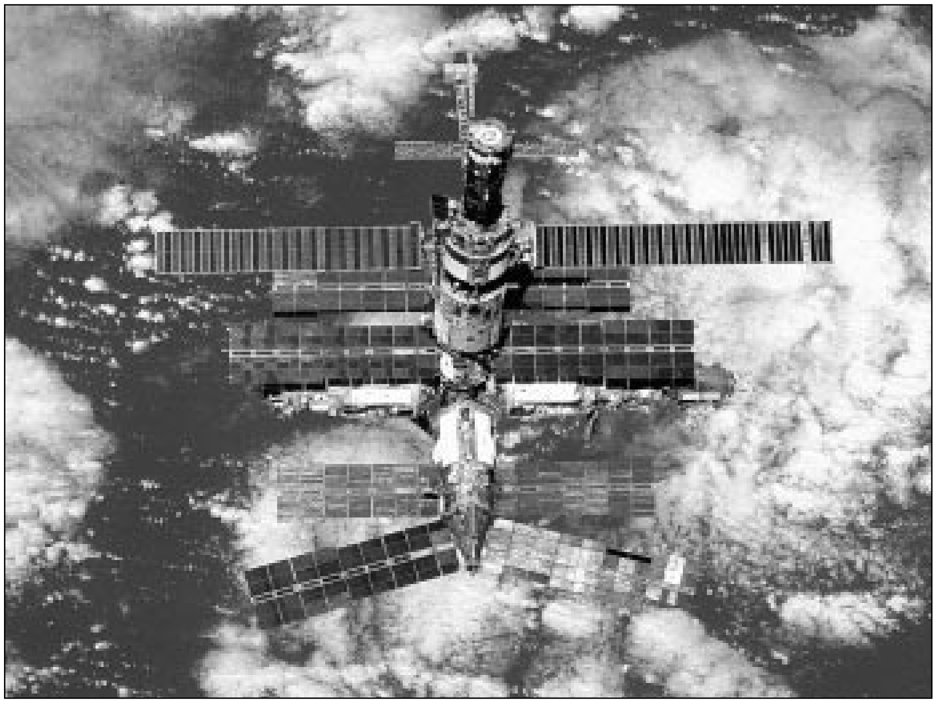
With John Blaha back on Earth the American presence on the Russian space outpost Mir continued with Jerry Linenger. Blaha arrived back on terra firma after a total of 128 days in orbit, 118 of those spent-for all intents and purposes—in a foreign country.

"Welcome! Welcome! Welcome!" Blaha said on January 14, when the hatches between Atlantis and Mir opened and a raucous round of greetings began. "Welcome to space station Mir, a truly international space station."

Moments earlier, STS-81 Commander Mike Baker and Mir 22 Commander Valery Korzun had embraced in the docking adapter connecting the two spacecraft, and pilots, flight engineers and mission specialists reveled in each other's companionship.

In addition to the exchange of crew members, Mission Specialist Marsha Ivins, Jeff Wisoff and the rest of the crew toted three tons of equipment, supplies and experiment samples back and forth between the two spacecraft. Another 1,600 pounds of drinking water were transferred to Mir's tanks using contingency liquid containers. The supplies and equipment will be used by Linenger and his crew mates as they conduct research over the next several months.

During a joint news conference, the Mir commander said, "We have



As seen from the Space Shuttle *Atlantis*, this 35mm frame affords a full view of Russia's Mir complex during approach for docking.

Space Shuttle *Atlantis*

January 12-22, 1997

Commander:	Michael Baker
Pilot:	Brent Jett
Mission Specialist:	John Grunsfeld Marsha Ivins Jerry Linenger John Blaha

Cosmonaut Valeri Korzun (second left), along with astronauts Michael Baker (second right) and Brent Jett, unstow a gyrodyne, a device used for attitude control, for transfer to Mir. Astronaut Marsha Ivins looks over a lengthy inventory of supplies to be transferred.

the greatest impression of the work we did together and the friendship we developed over the four months onboard."

"I think this program is not only about space exploration but also about the relationship between our two countries

and that's the most important thing," Blaha agreed. "In the course of this flight, our relationship among ourselves built up very well and I have the best of impressions of Russia and the Russians."

As Blaha rode back to Earth in a special middeck seat designed to make his readaptation to Earth's gravity more comfortable, Linenger was unpacking his gear and getting used to his new orbital home. As of January 24, 1997, Americans had spent 306 consecutive days onboard Mir.

Mission Events

NASA's first shuttle mission of 1997 began with the *Atlantis*' launch at 3:27 a.m. CST, January 12.

The first full day on orbit was spent activating the experiments in the Spacehab module, filling water containers with drinking water and checking out the tools to be used during the rendezvous and docking operations.

Prior to docking with Mir, the STS-81 crew activated a radiation monitor in addition to the Biorack multipurpose facility designed to investigate the effects of microgravity and radiation on plant, tissue, cell and fungus growth. In addition, a significant portion of flight day two was spent setting up and testing the on-board treadmill, which is designed for use in the Russian Service Module of the International Space Station (ISS). These tests evaluated the restraint system, motorization, running surface stability, and effectiveness in reducing disturbances to the microgravity environment during exercise.

Commander Mike Baker and Pilot Brent Jett guided *Atlantis* to the fifth linkup with Mir at 9:55 p.m. CST, January 15. The hatches were opened two hours later at 11:57 p.m. After an informal welcoming ceremony in the Mir's core module, the crewmembers conducted a safety briefing and went right to work, hauling top priority resupply items into the Russian station.

Atlantis and Mir undocked at 8:15 p.m. CST, January 19. After the shuttle separated from Mir, Pilot Brent Jett initiated a two-revolution fly around of the Russian complex at a distance of about 560 feet. At 10 p.m., Jett fired maneuvering jets to separate *Atlantis* from Mir to begin the journey home.

The fifth joint mission between the U.S. Space Shuttle and the Russian Space Station Mir concluded with a landing at Kennedy Space Center at 8:23 a.m. January 22, 1997. This ended 128 consecutive days in space for astronaut John Blaha, 118 of those were spent as a Mir crew member.

Payload Descriptions

FUNDAMENTAL BIOLOGY:

The microgravity environment on a long duration mission provides an ideal opportunity to determine the role gravity plays in molecular mechanisms at a cellular level and in regulatory and sensory mechanisms, and how this affects development and fundamental biological growth. Fundamental biology also is responsible for characterizing the radiation of the Mir environment and determining how it may effect station-based science.

Environmental Radiation Measurements: Exposure of crew, equipment, and experiments to the ambient space radiation environment in low Earth orbit poses one of the most significant problems to long-term space habitation. As part of the collaborative NASA/Mir Science program, a series of measurements is being compiled of the ionizing radiation levels aboard Mir. During the mission, radiation was measured in six separate locations throughout the

Left to Right, astronauts Jerry Linenger, Marsha Ivins and Peter Wisoff check out the treadmill vibration isolation stabilization system (TVIS) onboard *Atlantis*.

Mir using a variety of passive radiation detectors. This experiment will continue on later missions to measure and map the ionizing radiation environment of Mir. These measurements will yield detailed information on spacecraft shielding in the 51.6-degree-orbit of the Mir. Comparisons will be made with predictions from space environment and radiation transport models.

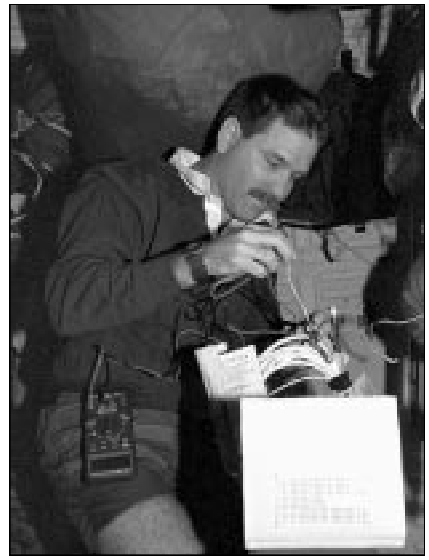
Greenhouse-Integrated Plant Experiments: The microgravity environment of the Mir space station provides researchers an outstanding opportunity to study the effects of gravity on plants, specifically dwarf wheat. The greenhouse experiment determines the effects of space flight on plant growth, reproduction, metabolism, and production. By studying the chemical, biochemical, and structural changes in plant tissues, researchers hope to understand how processes such as photosynthesis, respiration, transpiration, stomatal conductance, and water use are affected by the space station environment. This study is an important area of research, due to the fact that plants could eventually be a major contributor to life support systems for space flight. Plants produce oxygen and food, while eliminating carbon dioxide and excess humidity from the environment. These functions are vital for sustaining life in a closed environment such as the Mir or the International Space Station.

Wheat is planted and grown in the “Svet,” a Russian/Slovakian developed plant growth facility, where photosynthesis, transpiration, and the physiological state of the plants are monitored. The plants are observed daily, and photographs and video images are taken. Samples are also collected at certain developmental stages, fixed or dried, and returned to Earth for analysis.

Human Life Sciences: The task of safely keeping men and women in space for long durations, whether they are doing research in Earth orbit or exploring other planets in our solar system, requires continued improvement in our understanding of the effects of space flight factors on the ways humans live and work. The Human Life Sciences (HLS) project has a set of investigations planned for the Mir 23/NASA 4 mission to determine how the body adapts to weightlessness and other space flight factors, including the psychological and microbiological aspects of a confined environment and how they readapt to Earth’s gravitational forces. The results of these investigations will guide the development of ways to minimize any negative effects so that crew members can remain healthy and efficient during long flights, as well as after their return to Earth.

Assessment of Humoral Immune Function During Long Duration Space Flight: Experiments concerned with the effects of space flight on the human immune system are important to protect the health of long duration crews. The human immune system involves both humoral (blood-borne) and cell-mediated responses to foreign substances known as antigens. Humoral responses include the production of antibodies, which can be measured in samples of saliva and serum (blood component). The cell-mediated responses, which involve specialized white blood cells, appear to be suppressed during long duration space missions. Preflight, baseline saliva and blood sample are collected. While on Mir, the crew is administered a subcutaneous antigen injection. In flight and post flight, follow-up blood and saliva samples are collected to measure the white blood cell activation response to the antigen.

Diffusion-Controlled Crystallization Apparatus for Microgravity: Protein crystals are used in basic biological research, pharmacology and drug development. Earth’s gravity affects the purity and structural integrity of crystals. The low gravity environment in space allows for the growth of larger, purer crystals of greater structural integrity. Therefore, the analyses of some protein crystals grown in space have revealed more about a protein’s molecular structure than crystals grown on Earth. During STS-81, astronauts will retrieve protein samples that have been growing on Mir since the STS-79 docking on September 19 and replace them with new samples.



Astronaut John Grunsfeld performs an inflight maintenance task to reactivate power cables connected to experiments in the Spacehab Double Module.

In the experiment chamber called the Diffusion-controlled Crystallization Apparatus for Microgravity (DCAM), crew members will remove the “growing” samples and replace them with 162 new samples. The DCAM is designed to grow protein crystals in a microgravity environment. It uses the liquid/liquid and dialysis methods in which a precipitant solution diffuses into a bulk solution. In the DCAM, a “button” covered by a semi-permeable membrane holds a small protein sample but allows the precipitant solution to pass into the protein solution to initiate the crystallization process. The DCAM is a method to passively control the crystallization process over extended periods of time. The Principal Investigator is Dr. Daniel Carter of Marshall Space Flight Center in Huntsville, AL.

Gaseous Nitrogen Dewar: Frozen protein samples will be transported to the Russian Mir space station in a

As their respective roles are switched, Jerry Linenger (left) partakes of one of his first meals of Mir food while John Blaha has one of his final snacks aboard Russia's Mir space station.

gaseous nitrogen Dewar (GN2 Dewar) on STS-81, and the existing protein crystals on board Mir from the STS-79 mission will be returned to Earth for laboratory analysis. The Dewar is a vacuum jacketed container with an absorbent inner liner saturated with liquid nitrogen. The protein samples will remain frozen for approximately two weeks, until the liquid nitrogen has completely boiled off. This provides ample time to transport and transfer the Dewar to the Mir station. After the liquid nitrogen is completely discharged, the samples will thaw to ambient temperature and protein crystals will nucleate and start growing over the four-month duration of the mission. The Principal Investigator is the University of California - Riverside.

Liquid Metal Diffusion (LMD) using MIM: The LMD experiment will measure the diffusion rate of molten indium at approximately 392 degrees F. Diffusion is the process by which individual atoms or molecules move as a result of random collisions with neighboring atoms and molecules. Diffusion is difficult to study on Earth because gravity masks the effect of the collisions, that is, hot pockets of liquid rise while the more dense, cooler areas sink. Radiation detectors in the LMD hardware will measure the diffusive motions of a radioactive tracer in non-radioactive indium. The Microgravity Isolation Mount (MIM) will be used to isolate the experiment from vibrations which could disturb the liquid indium during the experiment and induce motions which are not diffusive. The MIM also will be used to provide measured vibrations for some samples to determine how easily diffusion can be affected by these forces. A total of five samples will be processed. The information obtained from diffusion measurements can be used to determine the rate at which material travels between two bodies of fluids separated by a stagnant layer which the material must diffuse through. This is a common occurrence for some types of crystal growth and alloy processing on Earth. The Principal Investigator is the University of Alabama - Huntsville.

Optical Properties Monitor (OPM): OPM is the first experiment capable of relaying on-orbit data which will measure the effect of the space environment on optical properties like those of mirrors used in telescopes, and structural elements like the coatings used on space hardware. OPM instruments will measure various optical properties of the overall experiment, showing to what extent the samples deteriorate over the course of the experiment.

Once aboard Mir, American astronauts and Russian cosmonauts mounted the monitor to the outside of the space station. This marked the first experiment deployed jointly by the U.S. and Russia.

Information gathered was used to improve designs of optical and structural elements of spacecraft, particularly the International Space Station. It also will be used to plan maintenance schedules for in-orbit satellites, based on measured rates of degradation.

OPM was developed by NASA's Marshall Space Flight Center and AZ Technology of Huntsville, AL. It is scheduled to be retrieved from Mir in February 1998 during the STS-89 mission. The Principal Investigator was AZ Technology in Huntsville, AL.

KIDSAT

The electric still cameras aboard *Atlantis* supported the second flight of KidSat, as part of NASA's three-year pilot education program designed to bring the frontiers of space exploration to 15 U.S. middle school classrooms via the Internet.

The pilot program is a partnership between NASA's Jet Propulsion Laboratory (JPL), the University of California at San Diego (UCSD), and the Johns Hopkins University Institute for the Academic Advancement of Youth (JHU-IAAY).

During the shuttle flight, the KidSat mission operations center at UCSD will be staffed by undergraduate and high school students. The center has capabilities similar to those of Mission Control at NASA's Johnson Space Center (JSC) in Houston. The students receive telemetry from the shuttle on their computer monitors and can listen to and receive instructions from NASA's flight controllers over direct channels to JSC.

The KIDSAT mission operations team monitors the shuttle's progress around the clock and continually provides up-to-date information to the middle schools, who are using the Internet to send instructions to photograph specific regions of the Earth. Since any change in the shuttle's orbit can affect students' selections, UCSD constantly updates this information so that the middle schools may re-plan their photograph requests if necessary. This is done through a sophisticated web site that allows middle school students access to interactive maps of orbit ground tracks and other resources to aid in photo selection.

When the image instructions have been verified by KidSat mission operations, they are compiled into a single camera control file and forwarded electronically to the KidSat representatives at JSC. They pass this file on to flight controllers who uplink it to an IBM Thinkpad connected to the KidSat camera. Software on the thinkpad, developed by students working at JPL, uses these commands to control the camera. These same students trained the astronauts on the use of the software and the installation of the KidSat camera in the shuttle's overhead window.

After the photographs are taken, they are sent back down to the KidSat Data System at JPL, staffed by high school students during the mission, and posted on the world wide web for the middle school students to study and analyze. The curriculum used by the middle school students and teachers was developed by the JHU-IAAY and UCSD. Teachers participating in the mission learn to use the curriculum during summer training workshops.

CREW BIOGRAPHIES

Commander: Michael A. Baker (Capt., USN). Baker, 43, was born in Memphis, TN, but considers Lemoore, CA, to be his hometown. He graduated from Lemoore Union High School, and received a bachelor of science degree in aerospace engineering from the University of Texas. Baker completed flight training and earned his Wings of Gold at Naval Air Station Chase Field, Beeville, TX.

Baker was selected for the astronaut program in June 1985. He was a veteran of three space flights including, STS-43 in 1991, STS-52 in 1992, and STS-68 in 1994, and with the completion of STS-81 has logged more than 964 hours in space. From March to October 1995, Baker was the Director of Operations for NASA at the Gagarin Cosmonaut Training Center in Star City, Russia, responsible for the coordination and implementation of mission operations activities in the Moscow region for the Shuttle-Mir program.

Pilot: Brent Jett (CMDR, USN). Jett, 38, was born in Pontiac, MI, but considers Ft. Lauderdale, FL, to be his hometown. Jett graduated from Northeast High School in Oakland Park, FL. He received a bachelor of science degree in aerospace engineering from the U.S. Naval Academy and a master of science degree in aeronautical engineering from the U.S. Naval Postgraduate School in 1989. Jett received his commission from the Naval Academy in May 1981 and was designated a Naval Aviator in March 1993.

Jett was selected for the astronaut program in March 1992. He was the pilot of STS-72 and with the completion of STS-81 has logged more than 458 hours in space.

Mission Specialist: Peter J.K. "Jeff" Wisoff (Ph.D.). Wisoff, 38, was born in Norfolk, VA. He graduated from Norfolk Academy. He received a bachelor of science degree in physics (with highest distinction) from the University of Virginia, a master of science degree and a doctorate in applied physics from Stanford University.

In his research career before joining NASA, Wisoff focused on the development of new vacuum ultraviolet and high intensity laser sources, and also collaborated on research on the applications of lasers to the reconstruction of damaged nerves.

He was selected for the astronaut program in January 1990. Wisoff served as a mission specialist on STS-57 in 1993 and STS-68 in 1994 and has logged more than 753 hours in space.

Mission Specialist: John M. Grunsfeld (Ph.D.). Grunsfeld, 38, was born in Chicago, IL. He graduated from Highland Park High School, Highland Park, IL. He received a bachelor of science degree in physics from the Massachusetts Institute of Technology, and a master of science degree and a doctorate in physics from the University of Chicago.

Dr. Grunsfeld's research has covered x-ray and gamma-ray astronomy, high energy cosmic ray studies, and the development of new detectors and instrumentation. He was selected for the astronaut program in March 1992, and served as

Crew in flight: Left to Right at bottom of frame, Peter Wisoff, John Blaha, Marsha Ivins, Aleksandr Kaleri. In the top half of Scene, from top left, Brent Jett, John Grunsfeld, Jerry Linenger, Michael Baker and Valeri Korzun.

STS-81
Quick Look

Launch Date:	Jan. 12, 1997
Time:	3:27 a.m. CST
Site:	KSC Pad 39A
Orbiter:	*Atlantis* OV-104—18th flight
Orbit/In.:	160 naut. miles 213 nm for docking 51.6 degrees
Mission Duration:	10 days, 4 hrs, 55 mns.
Landing Date:	Jan. 22, 1997
Time:	8:23 a.m. CST
Site:	Kennedy Space Center
Crew:	Mike Baker, (CDR) Brent Jett, (PLT) Jeff Wisoff, (MS1) John Grunsfeld, (MS2) Marsha Ivins, (MS3) Jerry Linenger (MS4-up) John Blaha (MS4-down)
Cargo Bay Payloads:	SPACEHAB-Double mod. Orbiter docking system
In-Cabin Payloads:	TVIS, Biorack, Kidsat, CREAM, Orbiter Space Vision Sys. MSX

STS-81 was the fifth Shuttle-Mir docking mission. The crew patch is shaped to represent the Roman numeral V. The Shuttle *Atlantis*, OV-104, is launching toward a rendezvous with the Russian Space Station Mir which is silhouetted in the background. *Atlantis* and the STS-81 crew spent several days docked to Mir during which time Astronaut Jerry Linenger replaced Astronaut John Blaha as the U.S. crew member on board the Russian Space Station. Scientific experiments and logistics also were transferred between *Atlantis* and Mir. The U.S. and Russian flags are depicted along with the names of the shuttle crew members.

mission specialist on STS-67/Astro-2 in 1995. With the completion of STS-81, Grunsfeld has logged more than 643 hours in space.

Mission Specialist: Marsha S. Ivins. Ivins, 45, was born in Baltimore, MD. She graduated from Nether Providence High School, Wallingford, PA, and received a bachelor of science degree in aerospace engineering from the University of Colorado in 1973.

Ivins was employed as an engineer and pilot at Johnson Space Center for several years prior to her selection for the astronaut program in 1984. A veteran of four space flights, Ivins was mission specialist on STS-32 in 1990, STS-46 in 1992 and STS-62 in 1994. With the completion of STS-81 she has logged more than 1,008 hours in space.

Mission Specialist: Jerry Linenger (Capt., Medical Corps, USN). After docking and a crew exchange, Linenger replaced John Blaha aboard Mir and officially became a member of the Mir crew. During his five-month stay aboard the station, he will conduct material, fluid and life science research before being replaced by U.S. astronaut Mike Foale.

Linenger, 41, was born in Eastpointe, MI. He graduated from East Detroit High School and received a bachelor of science degree in bioscience from the U.S. Naval Academy. He holds four advanced degrees: a doctorate in medicine from Wayne State University, a master of science in systems management from the University of Southern California and a master of public health degree in health policy and a doctor of philosophy degree in epidemiology from the University of North Carolina.

Linenger was selected for the astronaut program in August 1992 and served as a mission specialist on STS-64 in September 1994. With the completion of STS-81, Linenger had logged more than 506 hours in space.

Mission Specialist: John E. Blaha (Col., USAF, Ret.). Blaha was the third NASA astronaut to serve as a researcher aboard the Mir Space Station. Blaha, 54, was born in San Antonio, TX, and graduated from Granby High School in Norfolk, VA. He received a bachelor of science in engineering science from the United States Air Force Academy, a master of science in astronomical engineering from Purdue University, and graduated from the U.S. Air Force Aerospace Research Pilot School.

Blaha was selected as an astronaut in May 1980. Prior to STS-79, he had logged 33 days in space on four space missions. He served as commander on two flights—STS-58 in 1993 and STS-43 in 1991 and as Pilot on two flights—STS-33 and STS-29, both in 1989. With the completion of STS-81, Blaha had logged more than 3,864 hours in space.